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PRECIPITATION OF METALLIC COATINGS BY CHEMICAL REDUCTION OF NICKEL ON GLASS MICROSPHERES

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The conditions for chemical precipitation of nickel on glass microspheres are determined. It is demonstrated that nickel-plated glass microspheres can be used as conducting fillers in paint-and-lacquer materials to produce coatings for effective protection from EMR in a frequency range of 0.15 – 1000 MHz.

Conducting lacquer coatings attract special attention in view of the progress of radioelectronics and aircraft and aerospace engineering. While retaining all properties of polymer coatings (low density, high strength and elasticity of film, good adhesion and anticorrosive properties, and other valuables physicochemical and mechanical properties), conducting coatings acquire one of the most significant properties of metal, i.e., capacity for conducting electric current. Therefore, in certain cases they can be used instead of metals.

Conducting fillers are usually materials with high conductivity, such as soot, graphite, technical carbon, carbon fibers, powders of silver, gold, platinum, or nickel, etc. Of special interest is application of core pigments, i.e.,. combined metal particles (silver- or gold-plated copper and iron powders). The use of core pigments makes it possible to decrease the cost of highly conducting paint-lacquer composites. Of special interest are core pigments produced by metallization of glass microspheres, the mass production of which has become possible as a result of progress in plasma engineering. Glass microspheres acquire electric conductance in the course of metallization and can be used as a conducting component in various composites.

The purpose of the present study is to develop a procedure for chemical nickel plating of glass microspheres and to investigate the possibility of using them as conductor filler for paint and lacquer materials.

The class microspheres used in this study had particles of size 40 – 200 μm and bulk density of 0.063 g/cm^3. Before nickel plating, the microspheres were sensitized in a tin chloride solution and then activated in a 0.5 % solution of palladium chloride. Reduction of nickel was performed at a temperature of 82 – 84°C and pH equal to 4.5 – 5.5 in a solution containing (g/liter): 6 nickel chloride, 8 sodium hypophosphite, and 10 sodium acetate. Thermostatic control of the solution and stirring of the microsphere mixture are required to ensure process stability. The values of pH were measured using a laboratory pH meter (pH-340) with a glass electrode. The duration of nickel plating was 30 min. The weight increment of glass microspheres after nickel plating was 86.5%.

The structure of microsphere surface was analyzed using a JSM-350 scanning microscope at magnification × 1000 and a MP-7 microscope in reflected light at magnification × 25.

It can be seen in Fig. 1*a* that microspheres have an irregular spherical shape, are porous, and have a rough surface. The chemical nickel plating method used in the study pro-

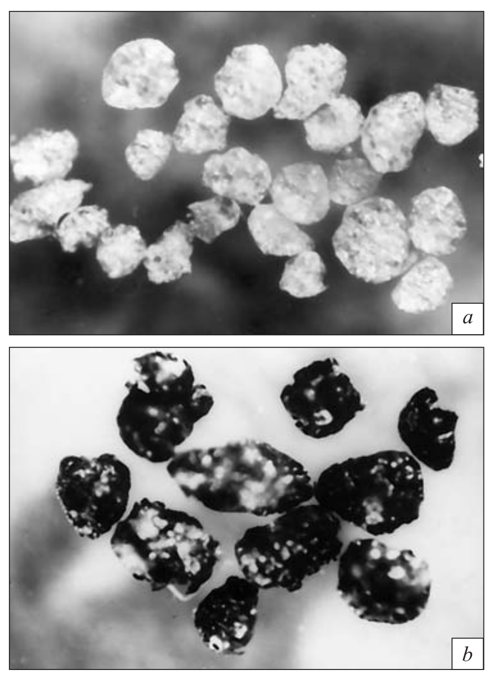

Fig. 1. Photos of glass microspheres in reflected light (× 25): *a*) initial; *b*) nickel-plated.

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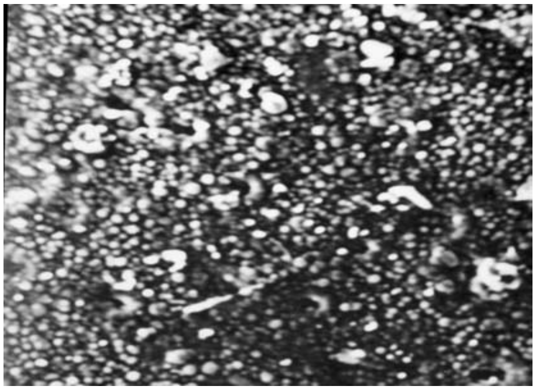

Fig. 2. Electron-microscope photos of the surface of nickel-plated microspheres (× 1000).

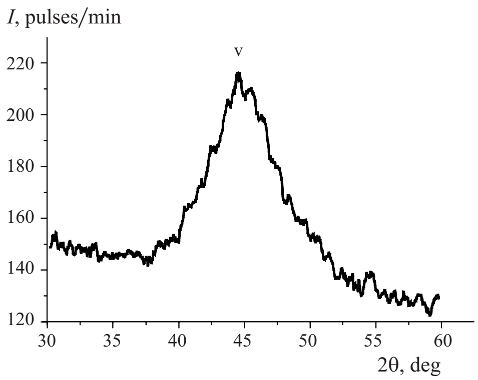

Fig. 3. X-ray diffraction pattern of nickel-plated microspheres: v) Ni.

vides for uniform precipitation of nickel onto the surface of glass micropsheres (Fig. 1*b*). The resulting coating had a gray color typical of nickel and metallic luster (the white dots on the surface of microspheres are light reflections). The microstructure of the surface of the nickel coating obtained on glass microspheres is shown in Fig. 2. The coatings exhibits a virtually uniform distribution of spherical nickel particles. X-ray phase analysis of the samples was carried out using a DRON-3 diffractometer (CuK_α radiation, nickel filter). According to x-ray phase analysis data, only one phase is present in the coating obtained, namely, metallic nickel (Fig. 3).

Calculations indicate that the majority of nickel particles have a size of about 35 nm.

TABLE 1

Sample	Weight ratio, %		Surface resistivity, Ω/□	EMR attenuation coefficient, dB
	lacquer AS-528	nickel-plated micropsheres		
1	98	2	2.0×10^4	–
2	95	5	905.0	4 – 8
3	90	10	250.0	6 – 10
4	80	20	98.0	12 – 20

Liquid composites were prepared by mixing 2 – 20 weight parts of nickel microspheres with 80 – 98% polyacrylic lacquer AS-528. The mixture was diluted to a viscosity of 80 – 100 sec using the diluting agent R-5 (GOST 8420–74). The composite was cast on plastic, wooden, and cardboard samples sized 3 × 3 cm. The drying duration determined according to GOST 19007–73 was 1 – 1.5 h, and the compatibility of the liquid composite with the surface coated and adhesion of coating to the substrate were determined according to GOST 29318–22 and GOST 15140, respectively.

The measurements demonstrated that liquid composites are compatible with the surfaces that were coated (plastic, wood, and cardboard), and the coatings have good adhesion to these materials.

The resistivity of the coating was measured using a Shch-4300 integrated instrument and the attenuation coefficient of electromagnetic radiation (EMR) in a frequency interval of 0.15 – 1000 MHz was found according to GOST 16.842–82.

The ratio of the quantity of binder to the quantity of the conducting phase determines the resistivity of the coating and the EMR attenuation coefficient in a frequency range of 0.15 – 1000 MHz (Table 1).

Thus, chemical precipitation of nickel to glass microspheres can provide for high surface conductivity.

Nickel-plated glass microspheres can be used as a conducting filling component for paint-lacquer materials to produce coatings effectively protecting from EMR in the frequency range of 0.15 – 1000 MHz.

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